Armed Forces College of Medicine

AFCM

Muscle Tissue-1

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INTENDED LEARNING OBJECTIVES (ILO)

By the end of this lecture, the student should be able to:

- Describe the organization of the skeletal muscle
- Describe the structure and correlated functions of the muscle fibers
- Describe the structure of the myofibrils
- Describe the structure and correlated functions of the sarcomere.

Classification

1. **According to morphology:**

   A. Striated B. Non striated

2. **According to function:**

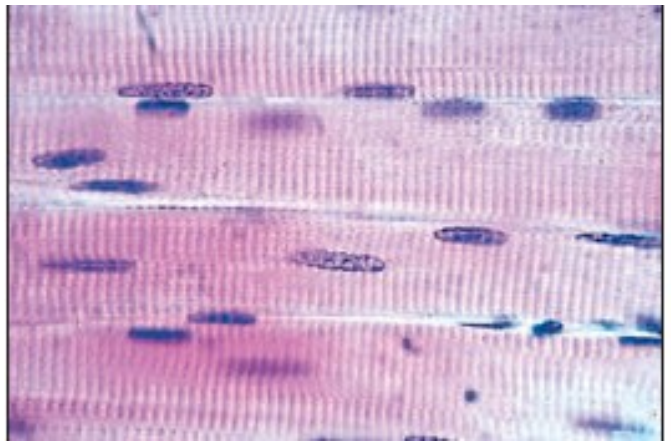
   A. Voluntary B. Involuntary

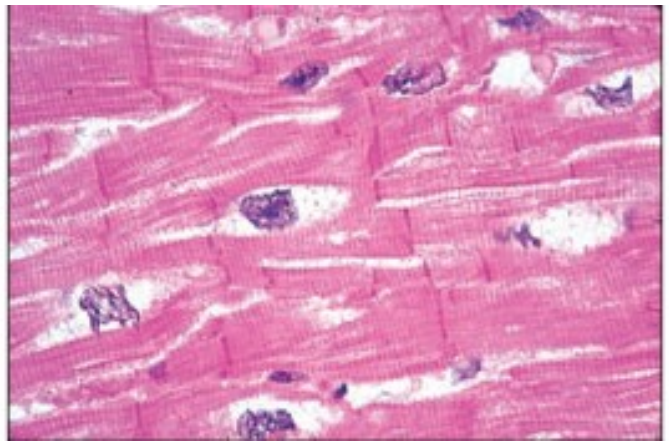
TYPES OF MUSCLE

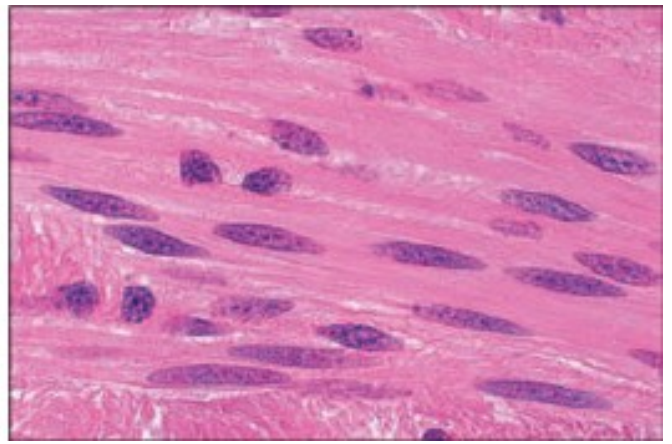
1. **Skeletal muscle**: striated &voluntary

2. **Cardiac muscle**: striated & involuntary

3. **Smooth muscle:** non striated & involuntary







Microscopic features of muscular tissue

1) It is formed of Muscle Cell (Muscle fiber)
2) The cytoplasm is called Sarcoplasm
3) Sarcoplasm contains {myofibril-sER-mitochondria-myoglobin} to serve its contractile function.
4) SER is called Sarcoplasmic reticulum
5) The plasma membrane is called Sarcolemma

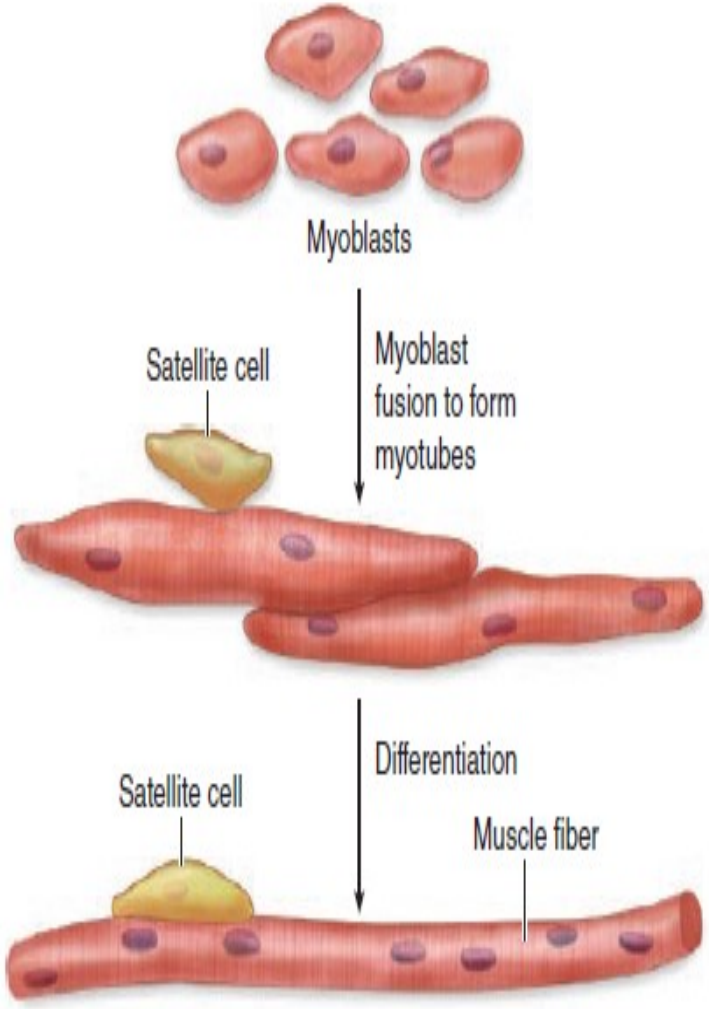
Skeletal muscle

Skeletal Muscle

- **Origin:-**

1. Prenatal life: Myoblast myotubes muscle fiber

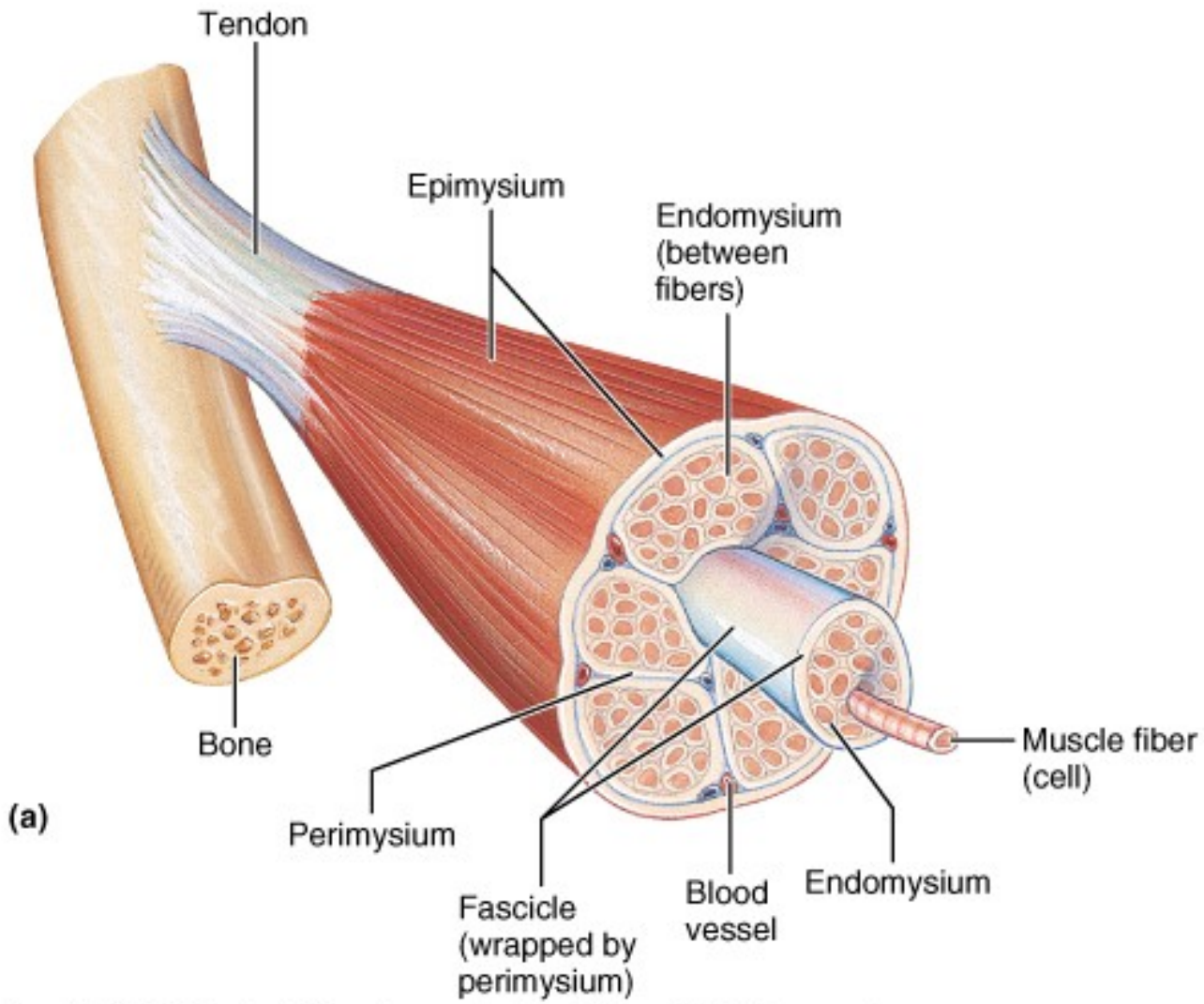
2. Postnatal life: Satellite cell (*myoblast population does not fuse and differentiate but remains as a group of mesenchymal progenitor cells*)



- Growth & repair of skeletal muscle occurs by satellite cell.
- Hypertrophy-hyperplasia???

The connective tissue wrappings

Organization of a skeletal muscle



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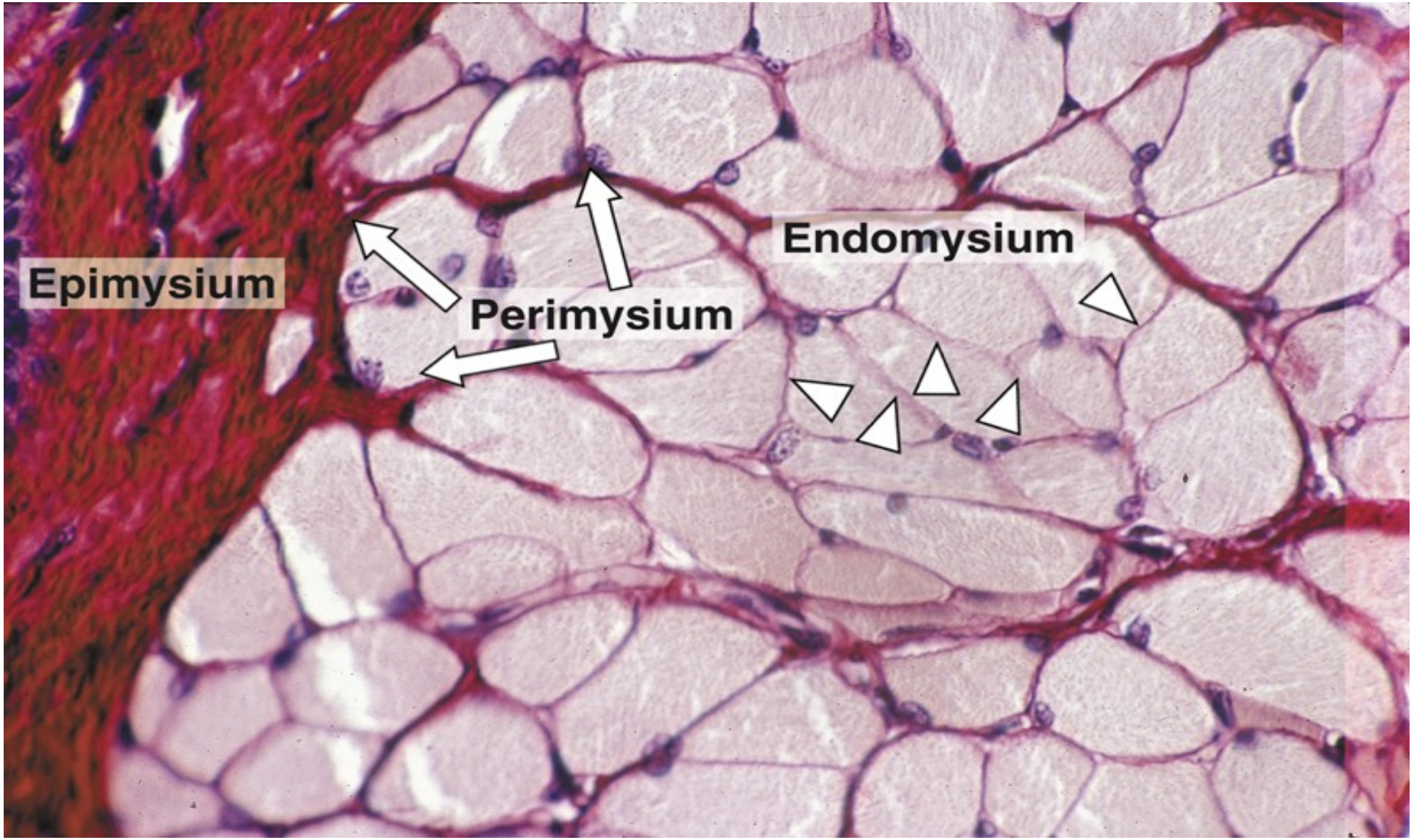


Cross section of striated muscle stained to show collagens type I and III and cell nuclei. The **endomysium** is indicated by arrowheads and the **perimysium** by arrows. At left is a piece of **epimysium**.

Connective tissue of skeletal muscle

1) **Epimysium**: dense CT covers the **whole muscle**.

2) **Perimysium**: dense CT surrounding each **muscle bundle**.

3) **Endomysium**: reticular fibers & fibroblasts surrounds **individual muscle fibers**.

Function: it carry blood vessels & lymphatic & nerves to the muscle.

Muscle Fiber by light microsc

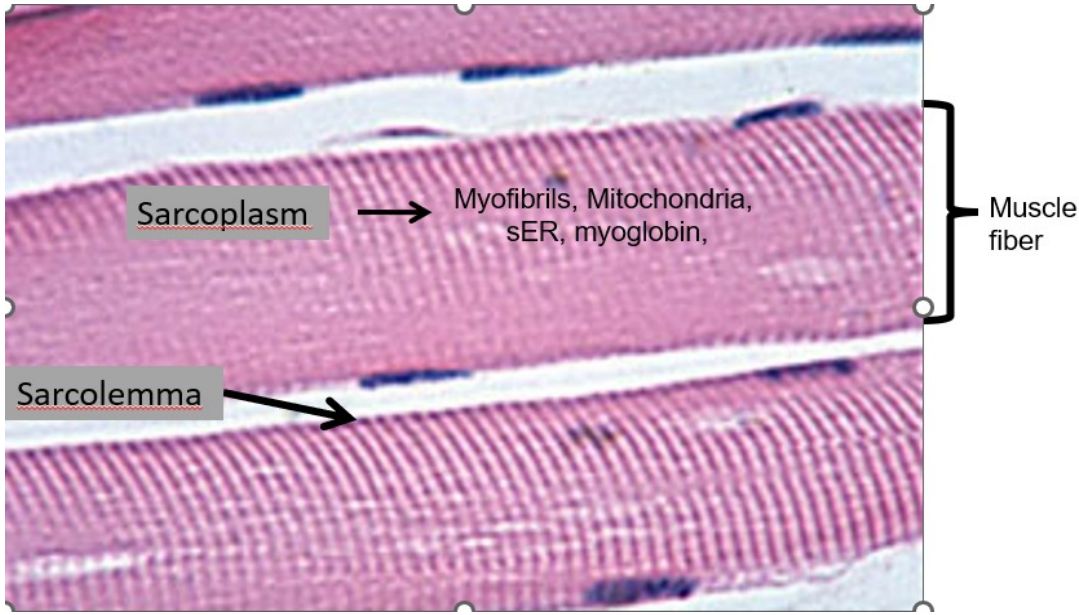
Light Microscope features of LS of sk muscle

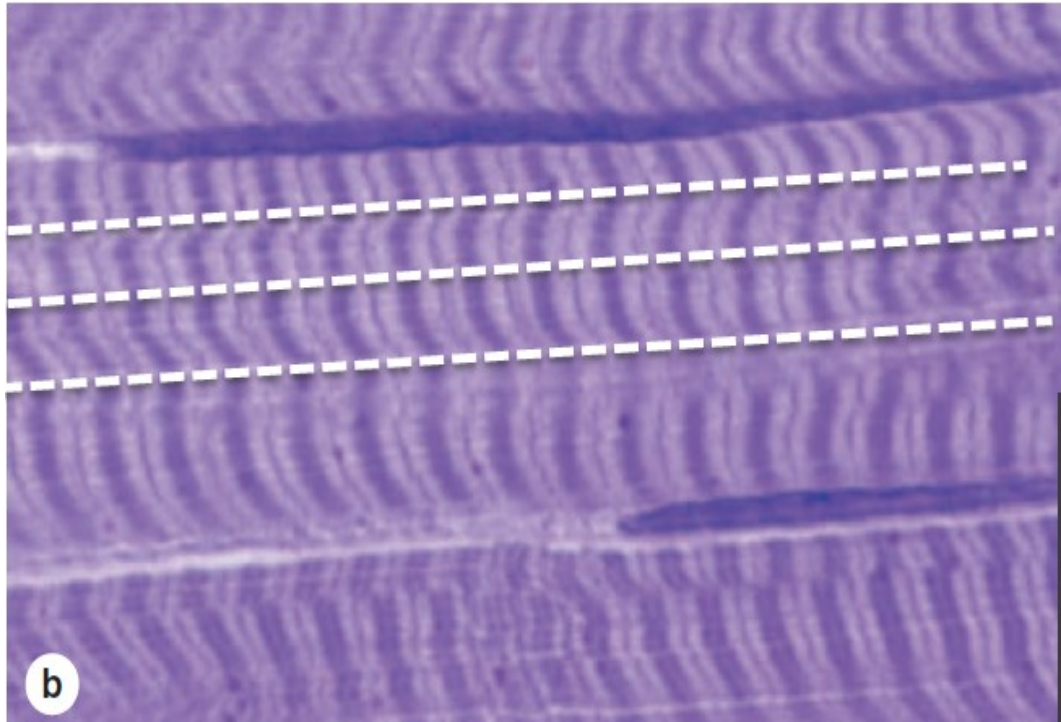
1. Shape:

- Cylindrical, non branched muscle fiber
- Surrounded by **sarcolemma** and separated from the surrounding C.T. by external lamina (+ve for laminin).
- It has wide diameter (10-100um)

2. Cytoplasm (sarcoplasm):

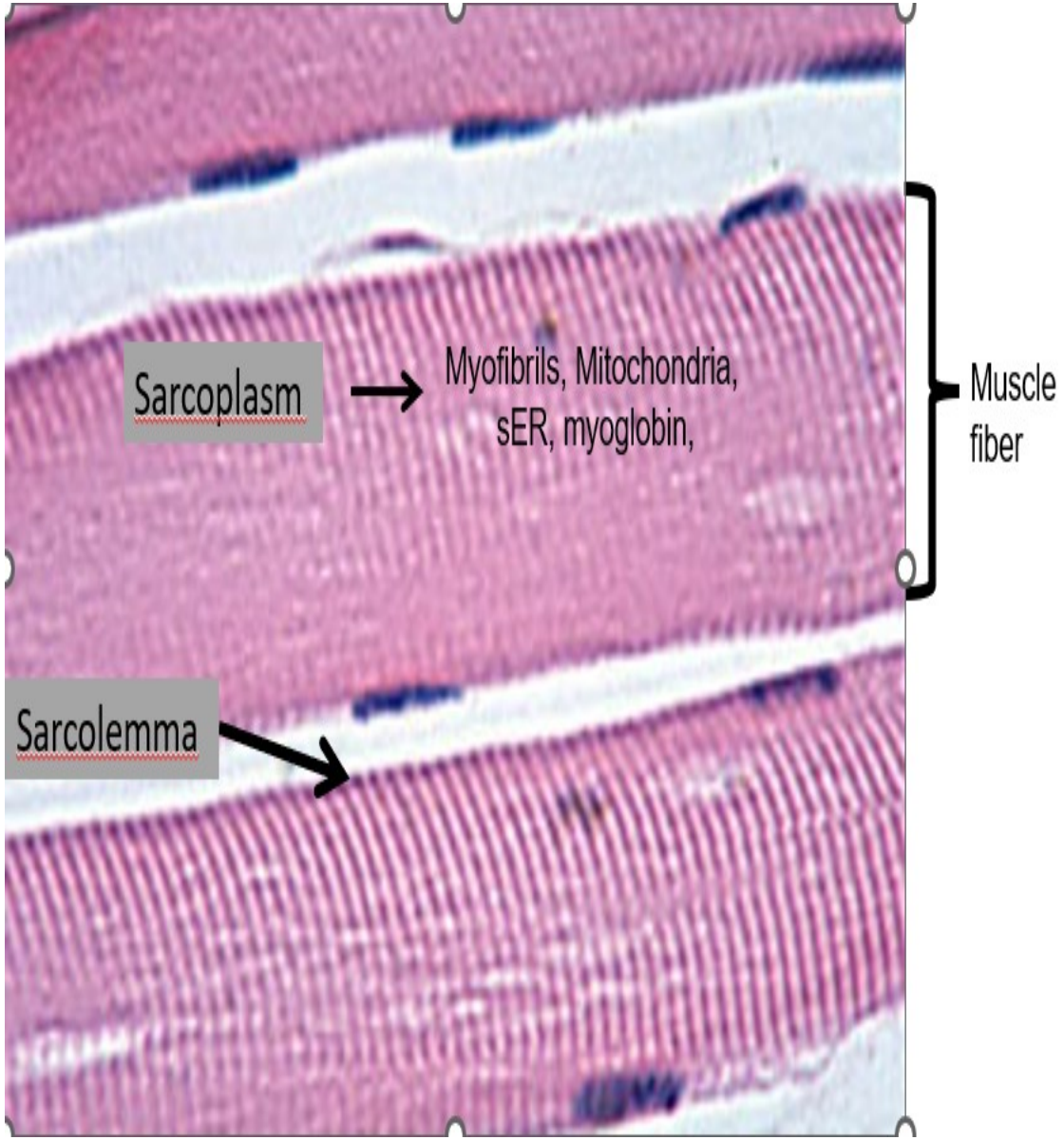
- It is **deeply acidophilic.**
- It shows **cross striations** of alternating light and dark bands
- It is rich in **myoglobin & glycogen.**
- Filled with long cylindrical bundles **myofibrils** that run parallel to the long axis of the muscle fiber
- The dark bands on the myofibrils are called **A bands**; the light bands are called **I bands.**





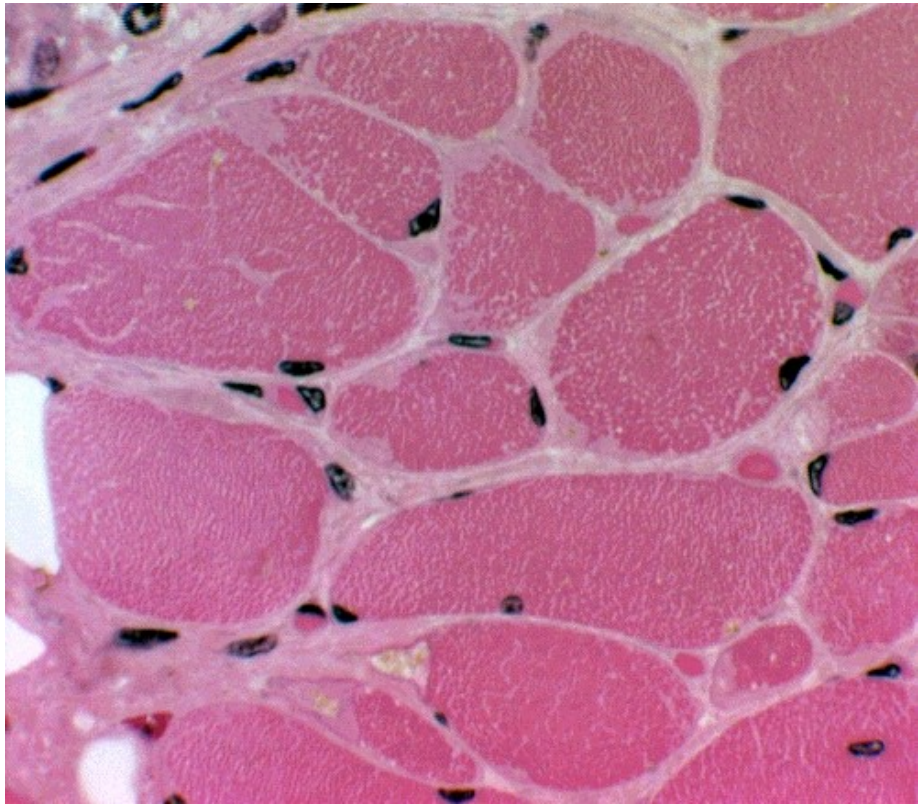
3. **Nucleus:**

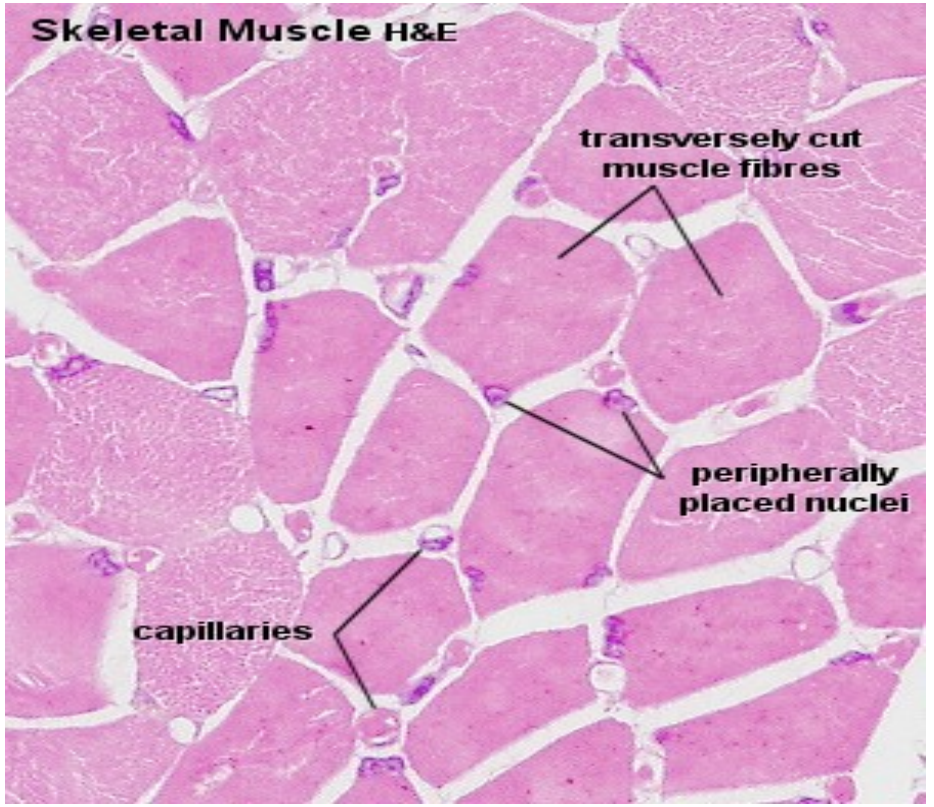
- Multi-nuclated cells.
- With flat oval nuclei.
- They are peripherally situated (just under the sarcolemma & parallel to it)



Light Microscope features of TS of skeletal muscle

- Rounded or polygonal
- Equal diameter
- Peripheral nuclei





Muscle Fiber by electron microscope

I.Organelles:

1. Myofibrils & myofilaments (sarcomere).

2. Sarcolemma & transverse tubules.

3. Sarcoplasmic Reticulum.

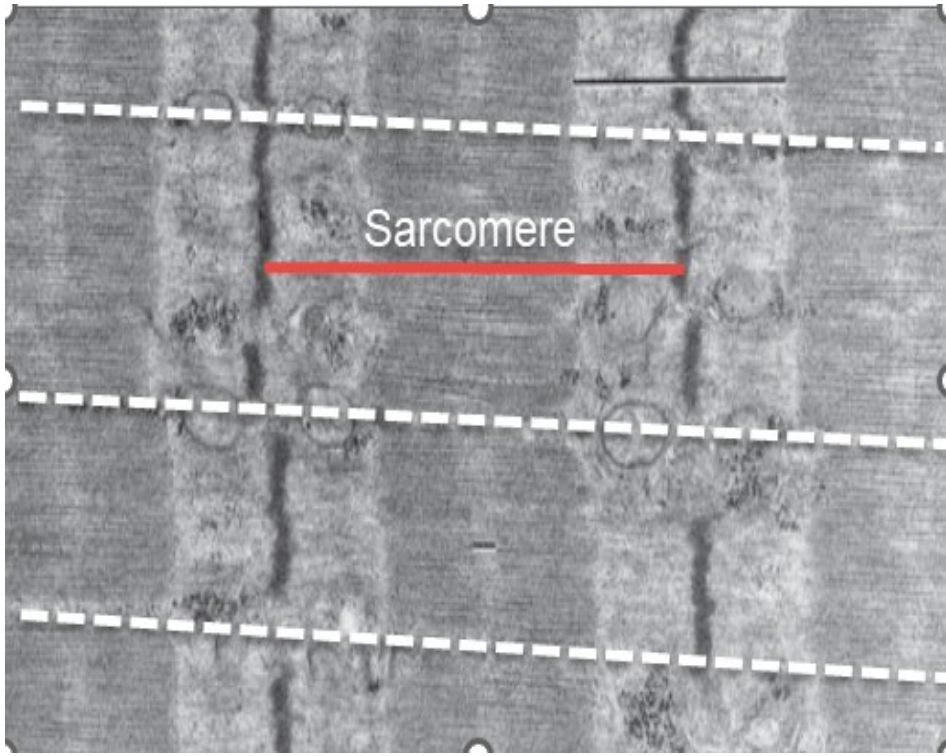
4. Mitochondria , Golgi & Ribosomes.

II. **Inclusions**:

-Myoglobin & glycogen

Muscle Fiber by electron microscope

- Sarcoplasm contains longitudinal parallel **myofibrils**
- Each myofibril is formed of repetitive functional units called **Sarcomeres** (about 2.5-µm long in resting muscle) characteristic pattern of transverse striations (Give reason for?)
- **Mitochondria, sarcoplasmic reticulum,**



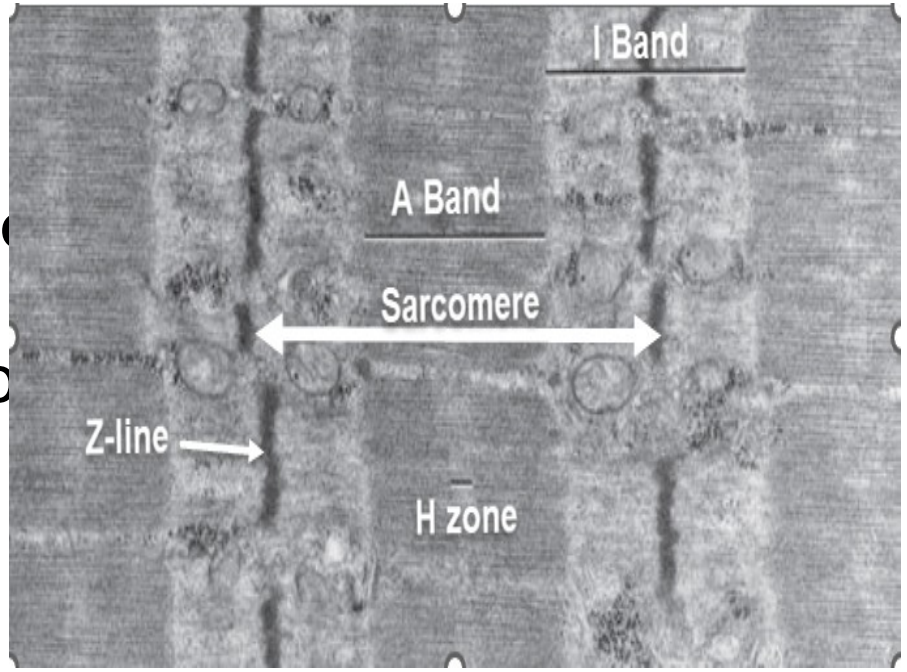
Myofibrils

Each myofibril is formed of a number of **myofilaments** arranged in **sarcomeres**

The A and I banding pattern in sarcomeres is due to the regular arrangement of thick and thin **myofilaments**, composed of **myosin** and **F-actin**, respectively

Sarcomeres are the **functional and structural**
muscle.
Each sarcomere is the **area between two succ**
lines.
The arrangement of myofilaments in sarcomere fo

- A Band (1 per sarcomere)
- I Band (2halfs per sarcomere)
- H zone
- M line



Sarcomere

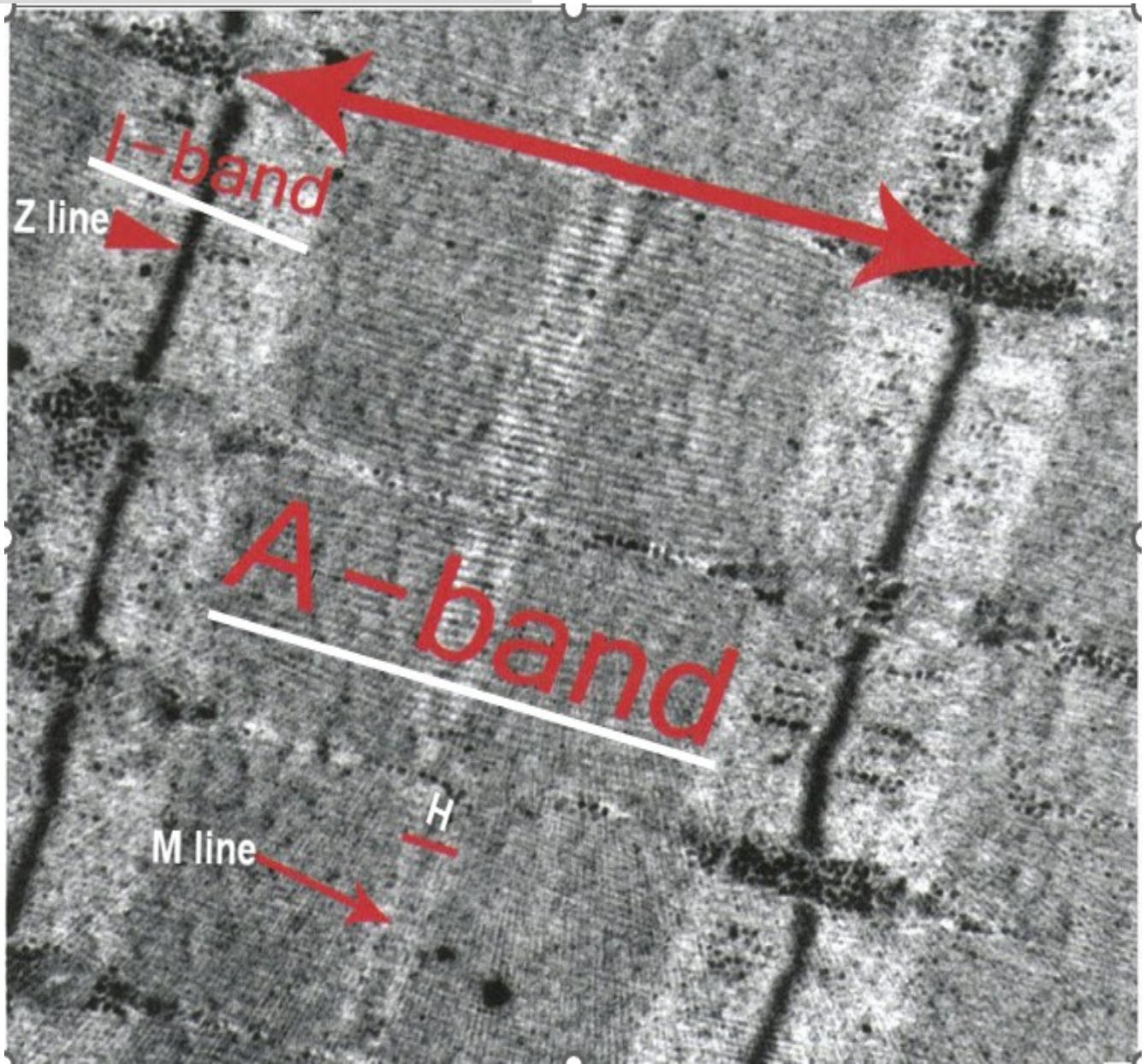
- Functional contractile unit.
- Bet. 2 successive Z line.

-**Sarcomere consists of:**

- **Dark band (A-band)** in the middle.
- **Half of light band** on either side.

-**H zone:** in the middle of A band.

- **M line** (in the middle of H zone).
- **Z line:** limiting the sarcomere on both sides.



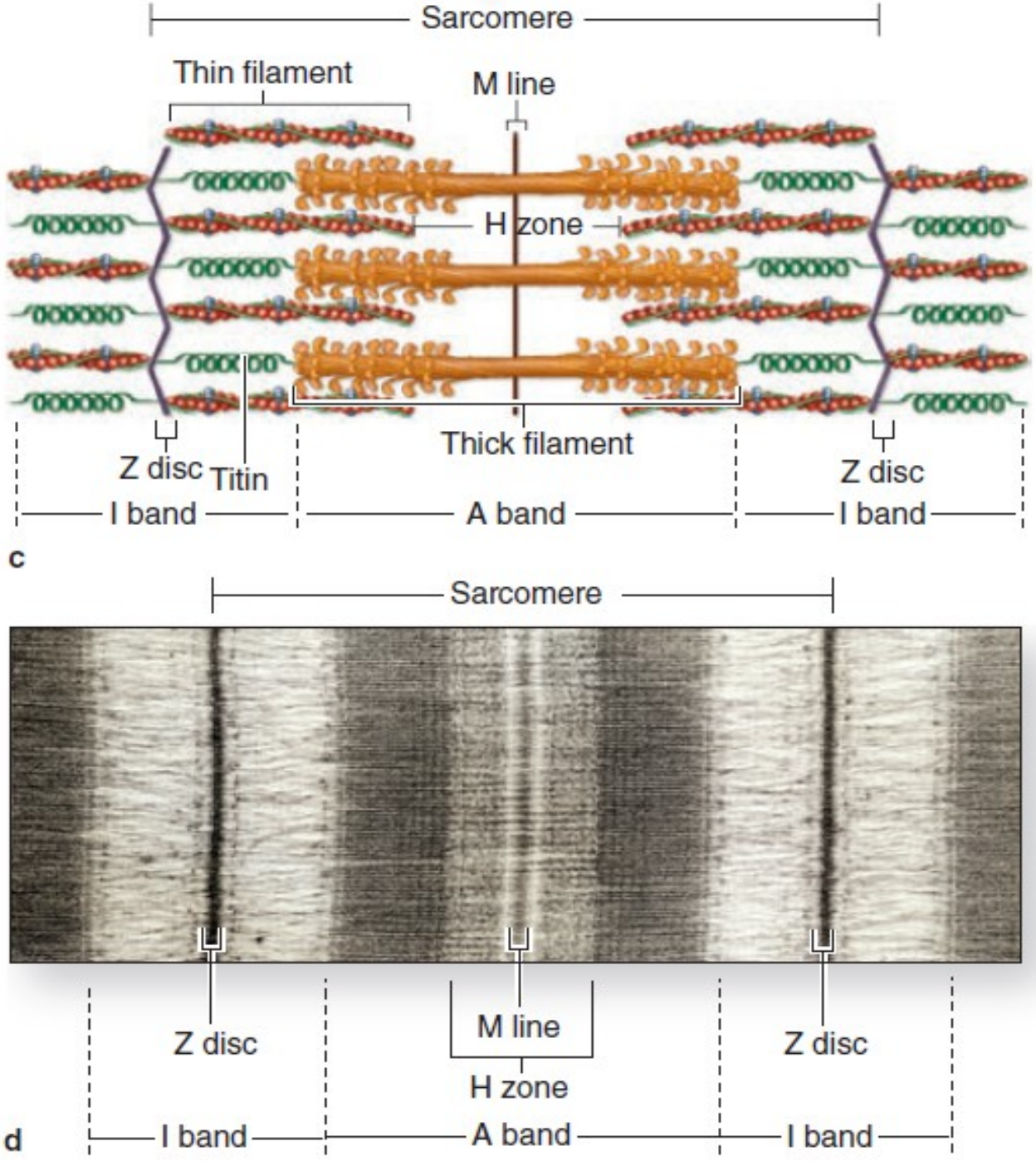
Sarcomere

✓**I band**: contains actin filaments only. Actin is anchored to Z line (by prot. ***Nebulin & α actinin***) but not reaching the middle.

✓**A-band:** contains both actin & myosin filaments. ***Titin*** protein binds myosin to Z line.

✓**H-zone:**(lighter area in the middle of A band) contains **myosin** only.

✓**M-line:**(is a dark line at the center of H zone) where adjacent myosin are held



N.B.

- M-line contain myosin-binding protein ***myomesin*** that holds the thick filaments in place, and ***creatine kinase***. This enzyme catalyzes transfer of phosphate groups to ADP□ATP for muscle contraction.

Types of myofilaments (Thin & thick filaments)

1.Thin filament {actin}:

- It is 8nm D.

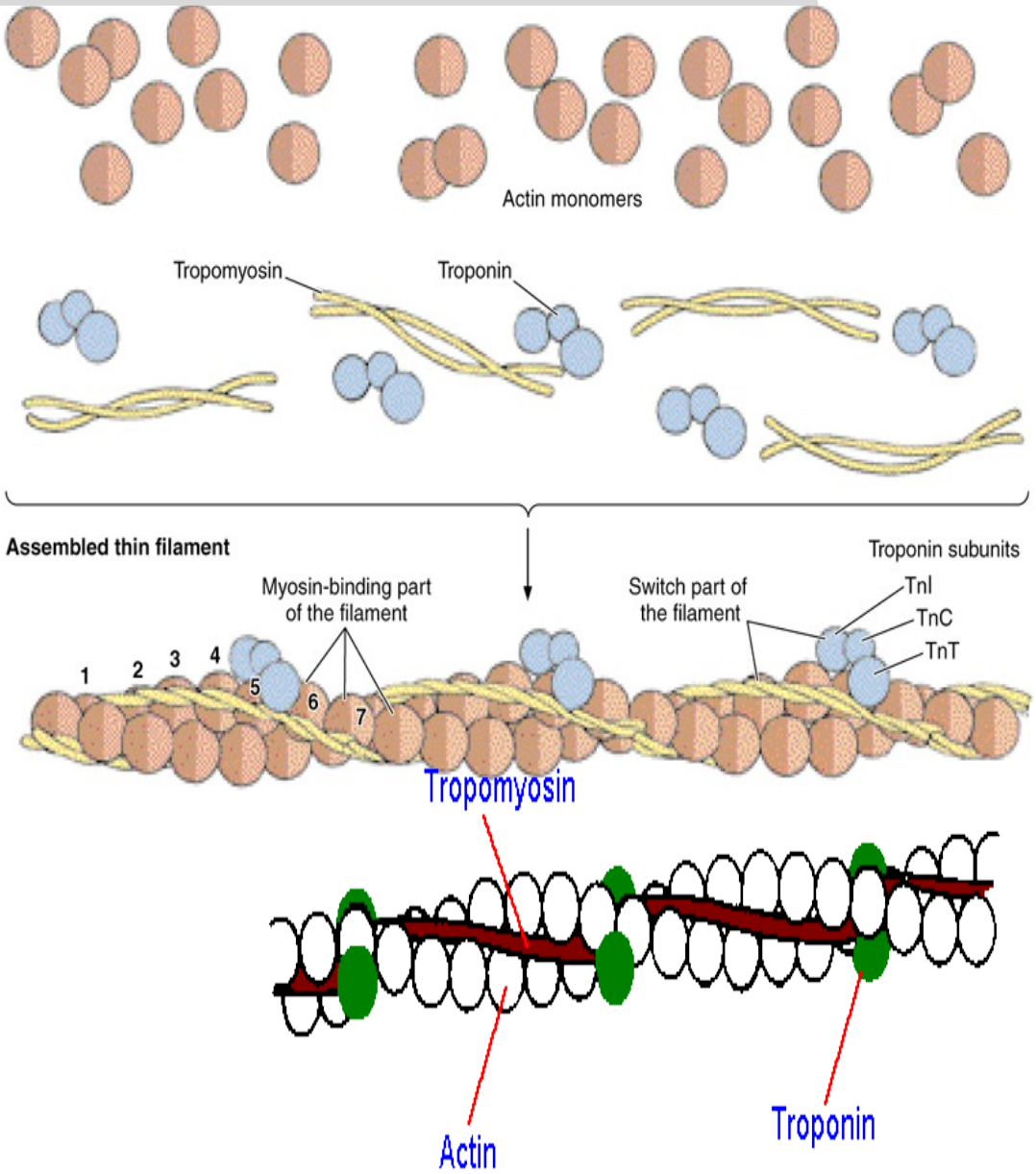
-It is composed of:

- **F-actin:** double helical polymer of G-actin protein
- **Tropomyosin:** coil of two polypeptide chains located in the groove between the two twisted actin strands
- **Troponin:**

-***Tn-I:*** inhibit actin myosin interaction.

-***Tn-C:*** binds to Ca ions.

-***Tn-T:*** strongly binds to tropomyosin.



Types of myofilaments (Thin & thick filaments)

2.Thick filament {myosin}:

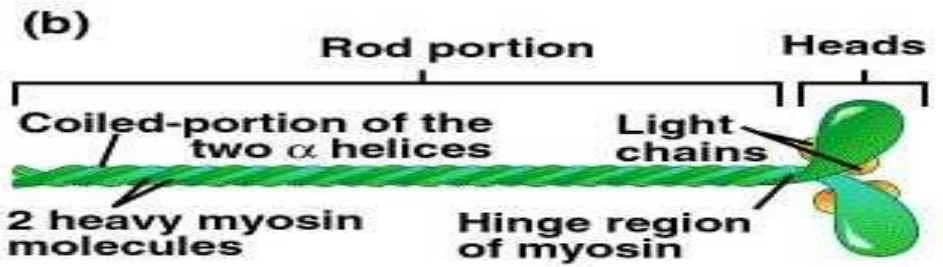
-It is 15nm Diameter.

-It extends in the **A band only**.

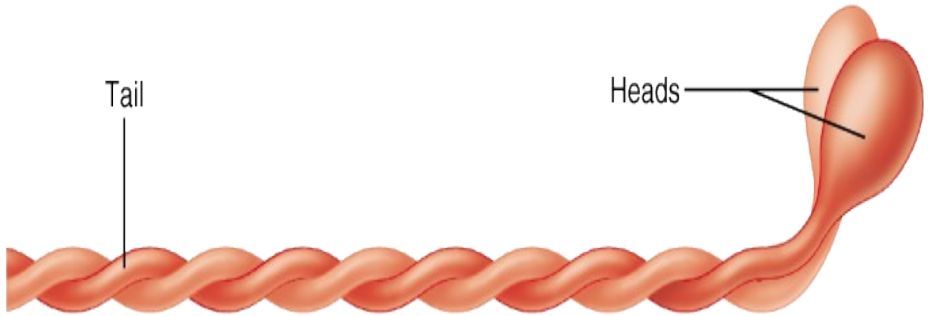
- Attached to the Z line by **titin**

-It is formed of **two identical heavy chains** and **two pairs of light chains**.

- The myosin heads bind both actin, and ATP.



View of myofilaments structure



(a) Myosin molecule

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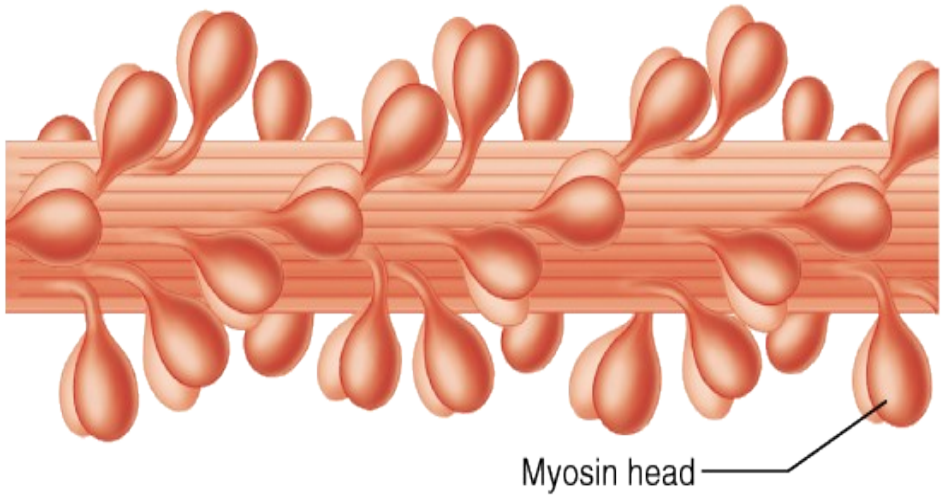

(b) Portion of a thick filament

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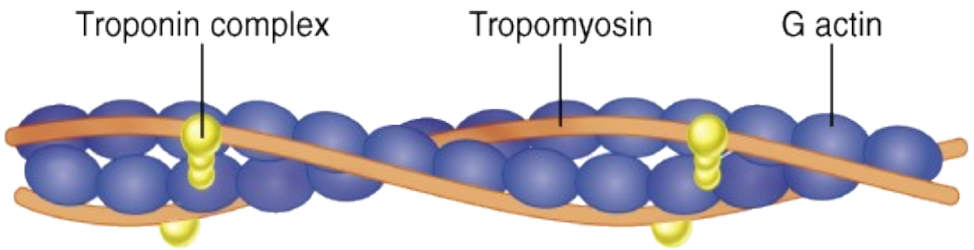

(c) Portion of a thin filament

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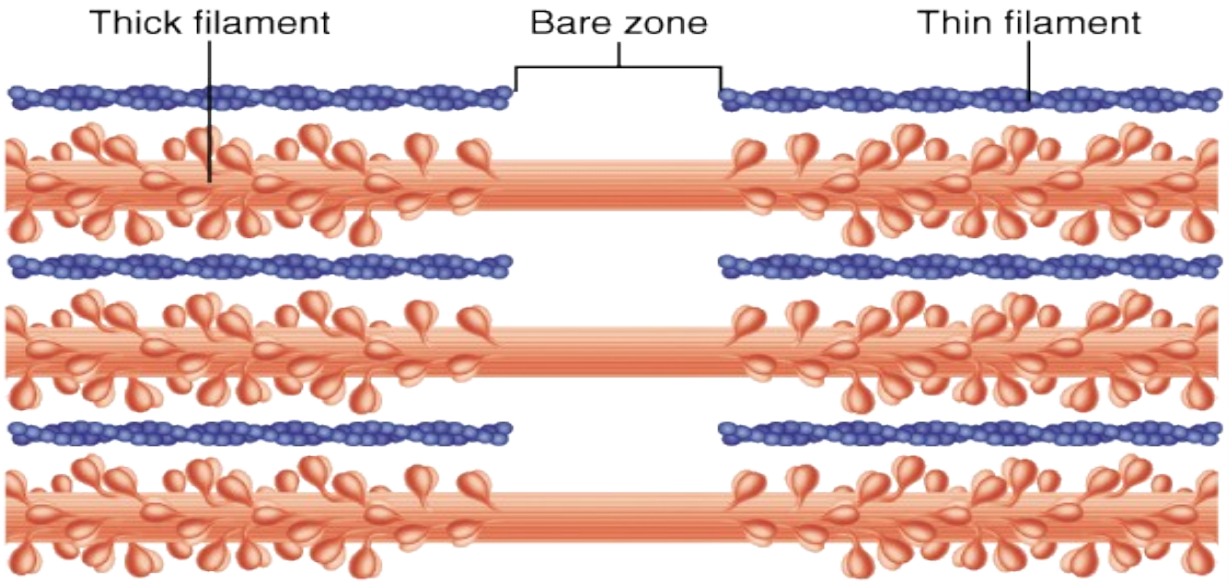

(d) Longitudinal section of filaments within one sarcomere of a myofibril

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